

Why Solar Leasing Is Financially More Attractive for A Rapid Increase of Distributed Solar Power in Developing Countries?

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Abstract:

A substantial decline in the cost of solar PV power plants (80% reduction since 2008) has enabled solar energy to compete with other power generation options in some developed markets. Other driving forces of PV boom in developed countries (Japan, USA) have been attractive policies together with innovative financing mechanisms. For homeowners lacking the financial capacity to purchase a solar home system, third party ownership particularly (solar leasing or power purchase agreement) has enable them to avoid high up-front costs. Through the review of journals, reports, case studies, the experience of USA over third party ownership has been studied. Further hypothetical examples have been used to explain how the lessons learnt from developed countries can be transferred to developing countries in order to increase their households' access to modern energy.

Keywords: Distributed solar energy; Third party financing; Solar leasing; Power purchase agreement (PPA); developing countries;

1. Introduction

Despite modest improvements in energy technology over the last two decades, 17% of global population (1.2 billion people) lack access to electricity and 38% (2.7 billion people) of the global population lack clean cooking facilities in 2013 (World Energy Outlook). More than 95% of these people are either in sub-Saharan African or developing Asia, and around 80% are in rural areas (IEA). People living in rural areas of developing countries are too poor and may be in too remote location to be reached by the national grid. For their daily lighting needs they rely on candles, kerosene lanterns, and firewood which are expensive in the long run. Even people living in urban areas sometimes rely on candles, kerosene lanterns during power as many of them frequently suffer from grid connections and transmissions that are of poor quality. The World Energy Outlook emphasized on the essential role of access to modern energy for the provision of clean water, sanitation and healthcare and for the provision of reliable and efficient lighting, heating, cooking, mechanical power, transport and telecommunications services.

As most of developing countries have solar irradiation and some with high insolation rates, small distributed solar energy systems which have been of strategic importance in empowering developed countries can also play an important role in bringing modern energy to developing countries. The technology costs fall together with attractive government incentives have greatly contributed these recent years in the boom of distributed solar energy in USA, Australia, Japan.

Innovative financing mechanisms such as third party ownership have also considerably increased the proliferation of solar panels on the roof of many low-income households in USA.

Our concern in this paper is therefore to figure out how the third party ownership can support the achievement of small distributed solar energy in developing countries and. The purpose of this research is to learn from USA's experience of third party financing in providing low-income families with distributed solar PV.

2. Literature Review

2.1 Advantages of distributed generation solar PV (DGSPV) for developing countries

According to Solar Energy Industries Association (SEIA), distributed generation (DG) refers to electricity that is produced at or near the point where it is used. Distributed solar energy can be located on rooftops or ground-mounted. While enhancing the quality of life with less pollution, distributed generation solar PV (DGSPV) can be attractive during high peak energy prices.

Solar photovoltaic has the potential to meet the electricity needs of rural communities in developing countries, (Oparaku, 2006). Indeed, the dispersed nature of solar resource makes PV systems more appropriate to meet the electricity needs of remote and dispersed rural communities. They may produce competitive electricity in sites with high solar resource and can easily be maintained by local communities thus enhancing job creation, (Marco Raganella, 2014). Small distributed capacity provide an effective and affordable way to bring light to people without electricity, (Steve Dahlke,), especially when applied in mini-grid or off-grid rural settings where power line extensions are too costly or where line construction will take considerable time to complete (BCSE, 2004).

2.2 Barriers for financing DGSPV in developing countries

When it comes to invest in renewable energies, developing countries face more challenges than developed countries, (Kimura, Chang and Li, 2016). Some scholars found that the high cost of debt with the high interest rates is the most pressing problem facing renewable energy financing in developing and particularly in India (Shrimali et al. 2013). The cost of debt is more expensive in India for the same project, same infrastructure than in developed countries. These cost and terms of debt add about 24–32% to the cost of renewable projects when compared to similar projects in the West. Immature financial markets, higher risks, inflation, and the lower saving rates of young populations were held to be the reason for this higher interest rate (Nelson and Shrimali, 2014).

Although China is one of the top World PV production, only 5% are domestically installed (Wei Long and Izuchukwu, 2013). Commercial banks and social sectors remain reluctant to fund distributed PV power generation for local installation because of the multiple financing risks involved such as the difficulties in defining rooftop property rights and using rooftop resources, policy risks, grid connection risks, uncertain profitability and difficulties in tariff collection. The difficulties in tariff collection generally occur when it comes to lease financing because this process comprises many actors (Guo-liang Luo and al. 2016).

The initial cost of Solar Pv, together with import duties and the technical issues were also held to be important barriers for Nigerian rural population (Oparaku, 2006). As most of the PV system components for the time being are not produced in developing countries (except China), there is a fear that their import duties may increase their costs. Also the lack of technical labor to support the operation and maintenance of PV systems which have been badly designed, installed or poorly managed by the customers may constitute a barrier in developing countries and therefore increase the total cost of the solar system.

Transfert LBC (2015) has studied the PV energy market in Brazil and found that individual or residential have difficulties of acquiring this new technology because of its high cost as in other countries. They discovered that individuals have more difficulties than commercial companies to get credit or loan from banks for solar projects. One of the reasons is that many banks perceive individuals in developing countries as high risk and even when they accept to provide individuals with credit, they usually require a high down payment, which is still too high for many low-income families (Steve Dahlke,). According to Scheutlich et al. (2001) rural customers can usually not offer suitable guarantees to banks.

2.3 Financing options of DGSPV

Despite multiple barriers of financing distributed solar energy, some solar PV projects have been financed as well as in developed countries as in developing countries. Tongsopit, Mounghareon, Aksornkij, and Potisat (2016) review the international landscape of financing options for rooftop solar system investment with a focus on the financing modes used in Thailand. Their review revealed 4 categories of financing options worldwide (the conventional self-financing, localized municipal financing and utility financing, third-party financing, and crowdfunding. For Thailand, they identify solar loan as the primary financing option.

Third party financing and internet financing are two new and innovative tools that have driven the rapid growth of distributed solar PV (DSPV) in the United States while in China, their rise is still meeting many challenges (Zhang, 2016). Hobbs, Benami, Varadarajan and Pierpont (2013) found that over 75% of California's new residential solar systems in 2012 were leased as compared to less than 10% in 2007.

Dukan and Hofman (2015) asserted that the use of micro-financing can play an important role in developing countries by offering credit or loans to low-income families which will help them to purchase low-carbon energy systems. Pode (2013) also recognized the role of micro-credit and Fee-for service in acquiring solar home systems (SHS) by the rural population but believed that their use is not enough to cover all the financing needs of the population (total cost, up-front price, and payment flexibility). He suggested the One-Stop-Shop financing model which according to him ensures microfinance (various financing options), installation (solar home and other micro-energy systems), maintenance, after sale service, and guarantee of energy supply with an affordable monthly fee even after the payment of complete loan.

Through case studies, Lam and Law (2016) found that crowd-funding is suitable for the inception of small-scale renewable energy and green innovation projects and for supporting research and development efforts of innovative green technology start-ups. Another financing method was proposed to fund solar home systems in developing countries rural areas (Diouf, 2016). Called "*tontine*", this method of financing is a traditional self-help organization that can provide funds to its members without guarantees or high interest. It has saving and lending as a primary or sole function and is popular in African countries (Senegal, Cameroon, Nigeria).

In summary, small distributed solar energy in developing countries may provide people with lighting, heating, refrigeration, cooking, water pumping, and other services that are essential for reducing poverty, improving health and education, and increasing incomes. However, as the upfront costs along with the cost of operation and maintenance, the families' low incomes and their difficulties to get credit from banks have to this date limited the purchase of PV systems in developing countries, we believe that third party financing which has

been successful to empower low-income households in some developed countries may be the more practical and economical tool to allow developing countries to rapidly access modern energy.

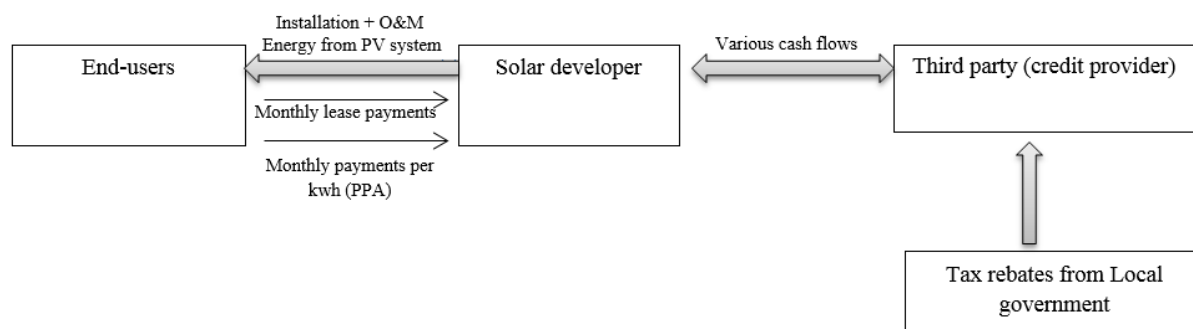
3. Methodology

Our methodology for this work is first to review the primary published literature on financing distributed generation solar energy. This approach was suitable for identifying the financing mechanisms of distributed solar energy and identifying the barriers for their financing in developing countries. As the review of the literature addresses the third party financing as the most appropriate financing mode for increasing residential solar energy, further review of reports, papers, presentations, case studies was also been conducted for investigating why and how third party financing may be appropriate for individuals in developing countries. In order to obtain a better understanding of third party financing, the research was prepared on the perspective of both solar developer/installer and end-users.

A case study on US solar companies has been realized to address third party financing issues. Given the complexity of conducting an effective survey within the end-users of solar energy through third party financing, our data related to end-users' comments on this innovative financing mode were collected from internet forum. All the speakers' comments collected from these internet forums have in common the interest of using solar system through third party financing. The total number of the speakers is about 272. 80% of them already acquired solar system through third party financing and were commenting about their experience of using third party financing for solar systems. 10% involves other residential wishing to contract for third party financing but are still looking for some answers to their questions while the other 10% are some individuals working for solar energy companies and trying to advertise the performance of their solar products and services. All the respondents are from USA but are coming from different cities with different experiences. Their comments took place between April 17, 2013 to July 31, 2015.

Our research disclosed third party financing (TPF) as a new method of solar financing for consumers who lack initial investment capital to purchase a system or the capacity to own and maintain a system. Third party ownership attempts to address affordability by allowing the cost of solar energy to be purchased over a long period of time. 72% of US Residential Solar Installed in 2014 Was Third-Party Owned (Greentechmedia, 2015). Under TPF, a resident or business hosts a solar system that is owned by a separate investor (third party). As the owner of the solar system, the third party bears the cost of installation, operation and maintenance of the system. The separate investor can be a bank, a credit union, a public-private partnership or fund. In some cases, the separate investor can at the same time be the solar developer/installer, like solar city in US. The two alternatives of third party ownership are solar lease and power purchase agreement (PPA). Fig 1 presents the structure of a typical third party financing for DGSPV.

Fig1: Typical third party solar lease and PPA structure



4. Evaluating Residential Solar Leases and Solar PPAs on the perspective of Solar provider, developer/installer:

Table1 introduces the different advantages offered by solar leasing and PPA that are absent in cash purchase like savings and flexible payment through installment, installation, operation and maintenance cost supported by third party. By leasing you agree to a specified monthly payment with the right to use all the power produced by the system. Your payments are predictable, like rent of a car or house. With a power purchase agreement, you agree to buy the power generated by the system at a set price per kilowatt-hour. It means that you pay for all the electricity produced by the system whether you use it or not. The solar provider is the owner of the solar system and for this reason is entitled to all incentives, rebates, refunds and cash credits. In USA, the total tax rebates are generally 30% of the purchase price of the system.

Table1: Comparative analysis of solar leasing and Power purchase agreement

	Solar Leases	Residential Solar PPAs
Who buys the system?	Third-party	Third-party
Who owns the system?	Third-party	Third-party
Who takes advantage of most of the federal and state incentives available for solar?	Third-party	Third-party
Who bears the costs of installation, operations and maintenance of the solar system?	the third-party	Third-party
Who incurs the risk of damage or destruction	Third-party	Third-party
What is the duration of the contract?	Long term, generally between 10 to 20 years	Long term, generally between 10 to 20 years
What happens if the homeowner, before the ends of the contract, sells the home where the solar system is located?	Depends on the contract. But the solar can be removed or left on the roof.	Depends on the contract. But the solar can be removed or left on the roof.
Can the contract be renegotiated?	It depends;	It depends;
How is the payment mechanism?	Generally fixed installment by months; but may include an annual escalator (increasing payment each year).	Payment per kilowatt-hour (kwh) generated by the solar system. It may also include an annual escalator;
Do the contracts provide down payments?	Yes, but it is flexible and optional;	Yes, but it is flexible and optional
Do contracts provide performance guarantees of the system?	Yes, usually. Solar lease providers commonly provide minimum production guarantees.	Yes, usually. PPA providers commonly provide minimum production guarantees.
Is insurance coverage (protection against damage and theft) provided?	Yes;	Yes;
Can the solar system be bought during or after the performance of the contract?	Yes, but it depends on the purchase price agreed on the contract or the fair market value if there is not such agreement in the contract;	Yes, but it depends on the purchase price agreed on the contract or the fair market value if there is not such agreement in the contract;

Source: SolarCity; energysage; Solar Energy Industries Association (SEIA);

5. Evaluating Residential Solar Leases and Solar PPAs on the perspective of homeowners:

The collection of the previous data have introduced solar and PPA as the two strategic tools for increasing the share of residential solar system in USA. The following part will assess their effectiveness among end-users.

The research revealed that most of the respondents have contracted for a power purchase agreement and very few for a solar lease. Most of the contracts have been signed for a lease or PPA for 20 years approximately. Almost the people who have contracted for the solar lease are satisfied with the terms of their contracts and the performance of the solar system. No complaint was received at the time of the collection of data. But for those who have signed for PPA, about 20% are totally satisfied with the panel production and the contract including all the services provided. About 60% are satisfied with the performance of the system and not satisfied with the contracts and vice-versa. 10% are satisfied with their contracts but have some complaints about one or two technical issues. And 10% are still neutral claiming that they newly contracted for the system and cannot say anything yet.

Most of the complaints under PPA concerns the overproduction of the solar system installed. As the amount to pay is based on the electricity produced by the system and not on the electricity consumed, some of the end-users are paying for electricity not consumed. And where their panels overproduced, they can no longer make savings because they are also overpaying for the bills. However, it is worth noting that some of the solar developers have already found solution through payback at a low rate of the electricity overproduced (or not charging at all the homeowners). The other issue concerning overproduction is that the end-users who faced overproduction had difficulties to renegotiate their contract or to make their panels being changed. Therefore they are stuck with these overproducing panels till the end of the contract.

6. Discussion

6.1 Developing countries homeowners' interest in solar leasing;

Solar leasing and PPA have played a crucial role in the rapid growth of solar energy in US. It has particularly played an important role for low-income revenues in US to acquire solar system despite its expensive up-front costs. However, the issue of charging overproduction has made PPA less favorable to homeowners. We believe that PPA mechanism will be more appropriate for commercials and industries while leasing finance is more suitable for homeowners. Indeed, due to the very low income or lack of regular revenues of many families in developing countries it will be inappropriate to propose them a system where the price is not known in advance. Before signing it, they need to know the financial advantage of this agreement like the amount of the savings they will do every month or after a certain period of time if they opt for this mechanism. The research has shown that making savings was the most motivational factor of going solar through third party financing. It has also shown that when it comes to charging panels' overproduction, most of the homeowners were no longer making savings.

With solar leasing, people are more fixed on the savings they can do over a certain period of time and the monthly payment is fixed according to the customer revenue and energy needs. For example, if you have annual revenue of 10 000 USD and you usually spend 900 USD per year for a 3 bedrooms, one living room, one kitchen together with common items (TV, refrigerator, . . .). According to your past energy consumption estimation, a solar home system (SHS) of 10 000 USD is proposed to you. Since you cannot pay that 10 000 USD in cash (due to your multiple charges), you opt for a lease with zero down payment where you chose either to continue paying 900 USD per year (75 USD per month) and acquire the system after eleven (11) years and (one) 1 month or pay 500 USD per year (41.6 USD per month) and acquire the system after twenty (20) years. With a monthly payment of 75 USD you will start enjoy your investment after 11 years and 1 month as the owner of the system. While with a monthly payment of 41.6 USD you can start enjoy your investment first from the signature of the agreement as a lessee with annual saving of 400 USD during 20 years and secondly as the owner after 20 years. The other main benefits offered by solar leasing are the zero down payments, the cost of installation, operation and maintenance supported by the third party.

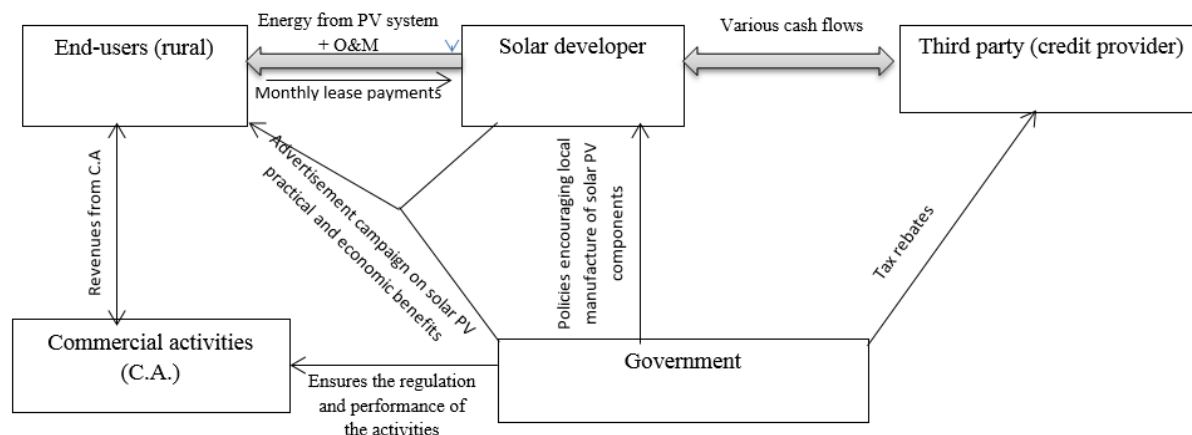
6.2 Third party or solar developer's interest

The review of the literature has shown that individual non-payment has always been the problem of investors, especially in developing countries. Under solar leasing, the research has revealed that third party or solar developer can get the return of their investment. Of course the payback period is not immediate but takes place during the lifetime of the agreement and is organized through monthly payment. Certainly individuals having secure job with secure payment would make the monthly payment but for those without a secure job or business would have difficulties to meet the payment. For these people, a prepaid card as in mobile phone system can be proposed to help them to have more control on their income and avoid penalties for overdue payment.

In rural area, we believe that the third party can also ensure the return of its investment under certain conditions. First, we know that energy enhances economic development. With energy we can develop a business or expand the scope of existing business. For example, with that solar energy, you can start a new business at night (shop, snack, night clubs, restaurants, entertainment) and make more revenues. If you already have a business but you needed to close earlier because of the lack of energy, with the new solar energy you will have the opportunity to close a little bit later or do extra time at work and increase your revenues. In rural area, with solar energy you can improve your agricultural activities so that the harvest is no longer for self or family consumption but for local or regional commercialization which will give you more revenues. Based on this conception, the third party can be sure that they can get return of their investment. And to make this concept viable, previous market research need to be done to know which kind of commercial activities can well respond to the development needs of the local population. This market research should be done along with the local government and the population.

In addition to provide attractive policies, the local government in this situation could act as a guarantee both for the solar energy provider (in terms of performance of their system) and rural community (in terms of the regularity of the payment). The solar developer and local government should advertise as much as possible the economic and practical advantages of solar PV in rural areas since most of their inhabitants lack interest in it because many of them are still unfamiliar to the affordability, reliability and sustainability of this new technology. Based on the above discussion, Fig 2 proposes a conceptual framework of solar leasing for developing countries.

Fig2: Conceptual framework of solar lease in developing countries



7. Conclusion

Providing reliable and sustainable energy services is crucial for the eradication of extreme poverty and economic development by underpinning industrial growth and providing access to the global markets and trade. Due to the high insolation of some countries, providing reliable and sustainable energy services through distributed generation solar PV (DGSPV) should no longer be an option but a necessity for developing countries who are suffering from severe grid connections and transmissions issues, especially remote rural areas communities who totally lack energy access. Third party ownership, already successful in some developed countries, can help developing countries households to address the affordability issue of solar PV. Its two main instruments, solar leasing and PPA, have helped low-income homeowners who can't afford the heavy upfront costs by allowing the system to be purchased by a third party with the generation sold over time to the customer. From the analysis of our research, we believed that the implementation of solar leasing in developing countries will offer more advantages to homeowners than PPA. We have suggested the use of PPA for commercials and industries because their energy needs are much higher than residential. Of course governments have a strategic role in the implementation of these models. While good policies will attract private investors, families have to be ensured that this innovative financing mode will help them to cover and meet their energy and financial needs.

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